Electrical Safety

OSHA

Be Smart. Be Safe.

Prepared by DGS Safety
April 2015

OSHA Be Smart. Be Safe.

Self-Study Course & Exam

To Receive Credit For This Course
Contact The Safety Office For A Test
Or Print A Copy From On-Line

Passing Grade is 70% Or Better

Note: Information For The Exam Questions Can Be Found In This Presentation. You Will Also Need To Refer To And Take The Related Course on **Lockout And Tagout of Hazardous Energies** Also Found On Safety's Webpage.

Overview

Electrical Work Is

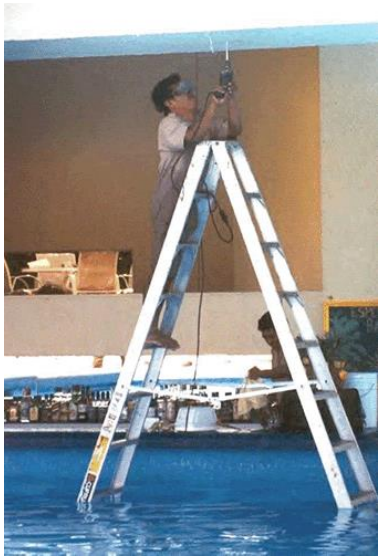
Hazardous

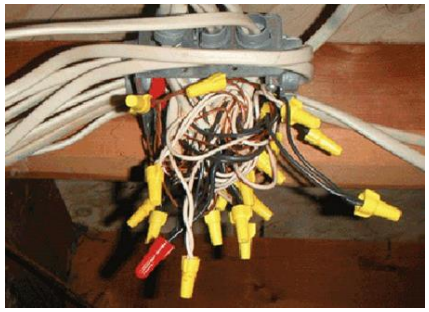
- Electrocution And Burns Are Significant Causes In Work Related Fatalities
  - A Majority Of These Incidents Occurred *At* ***<600 Volts***
  - Especially To Electricians / Helpers & Construction Workers
- **Arc Flash** & **Arc Blast** Are As Dangerous As Electrocution But Poorly Understood / Recognized As Electrical Hazards
- Falls (From Ladders)

ELECTRICAL HAZARDS

CAUSES:

- Unsafe Conditions
  - Faulty Insulation
  - Improper Grounding
  - Loose Connections
  - Defective Parts
  - Ground Faults In Equipment
  - Unguarded Live Parts
  - Underrated Equipment
  - Work Environment
- Unsafe Acts (Work Practices)
- Combination





Prevailing Mind Set
"**It Won't Happen To Me**"
(Famous Last Words)

SC LLR OSHA References NFPA 70E - Standard For Electrical Safety In The Workplace As A "How To Guide" Of Best Practices Using The General Duty Clause For Enforcement

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Training:

- **WHO** - Employees Who Face A Risk Of Electrical Shock That Is Not Reduced To A ***Safe Level*** By The Electrical Installation Requirements
  - Qualified Persons Who Work On The Equipment
  - Unqualified Persons Who Work Around The Equipment

- **WHAT** - Safety-Related Work Practices Required by OSHA 29 CFR 1910.331 Through 1910.335 That Pertain To Their Respective Job Assignments And Necessary For Their Safety

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Training:

Required By 29 CFR 1910.332

- Workers
  - Electricians
  - Electrical Engineers
  - Material Handling Equipment Operators
  - Painters
  - Welders
  - HVAC Mechanics
  - Maintenance
  - Industrial Machine Mechanics

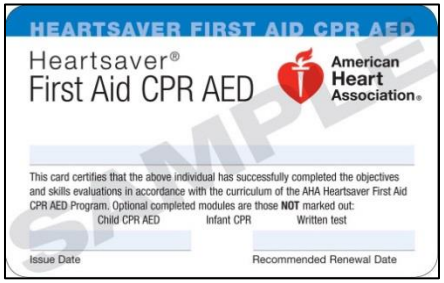
- Their Supervisors

Training:

1st Aid-CPR

When Employees Are Performing Work On Or Associated With Exposed Lines Or Equipment Energized At 50 Volts Or More, Persons Trained In First-Aid Including Cardiopulmonary Resuscitation (CPR) shall be available

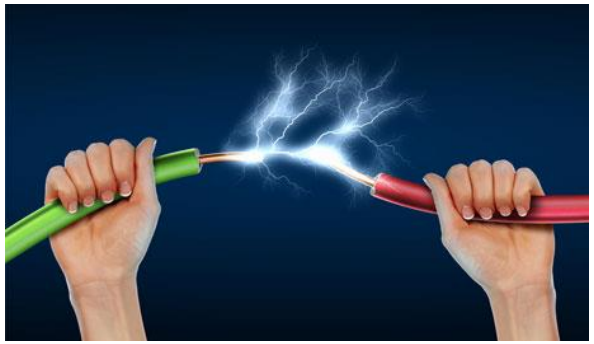
- All Facilities Management Trades Specialists Are To Be Trained is 1st Aid-CPR-AED
- AHA-Trained Safety Instructors Use The American Heart Association Course Which Requires Certification Every 2 Years



How Electricity Acts:

Behind Turning On An Electric Switch There Must Be:

- **Power Source** – The Power Generating Station
- **Transport Method** – Electric Current Travels Through Conductors, Normally In The Form Of Wires
- **Force** – The Pressure To Make Electricity Flow, Measured In Volts, Is Provided By A Generator



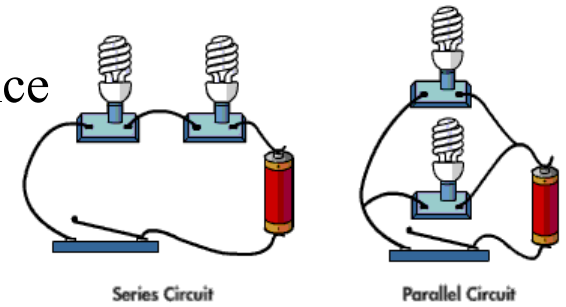
How Electricity Acts:
Volts or Amps Kill?

Voltage (V) is Pressure (increasing the voltage will make more current flow)

Current (Amps) is Flow Rate

Resistance (Ohms) to the flow of electricity depends on

- Nature of the Substance
- Length and Cross-Sectional Area of the Substance
- Temperature of the Substance



Current = Voltage / Resistance

Electrical Power (Watts) **= Voltage x Current**

Answer: See Next Page

How Electricity Acts:
Volts or Amps Kill?

Pass Cursor Over
Black Box
Then Click

Or Copy and Paste this URL -
https://www.youtube.com/watch?feature=player_embedded&v=9iKD7vuq-rY

DEFINITIONS

- **Qualified Person** – Those Permitted to Work On *(Direct Contact)* Or Near *(Due To Contact By Means Of Tools Or Materials)* Exposed Energized Parts Due To Training And Experience In The Skills And Techniques Necessary To:
  - Distinguish Exposed Live Parts From Other Equipment Parts
  - Determine Nominal Voltage Of Exposed Live Parts
    - Such As 120/240 and 480Y/277
    - Helps Determine Proper Work Procedures For The Job
  - Know The Approach Clearance Distances For The Corresponding Voltages To Which A Qualified Person Can Be Exposed
  - Be Able To Recognize What Protective Equipment And Tools Are Required For The Work Area And Properly Use Them
  - Follow Safe Electrical Work Practices

DEFINITIONS

- **Unqualified Person** – Trainee And / Or A Person Who Does Not Meet "Qualified Person" Criteria But Faces A Risk Of Electrical Shock
- **May** – Optional (Recommended)
- **May Not** – Prohibited
- **Shall** – Must Comply

Electrical Safety

OSHA Be Smart. Be Safe.

This video, produced by Square D-Schneider Electric, is a good overview of safe electrical work procedures we want to follow.

Pass Cursor Over Black Box Then Select the Play Button ▶ At Bottom Left

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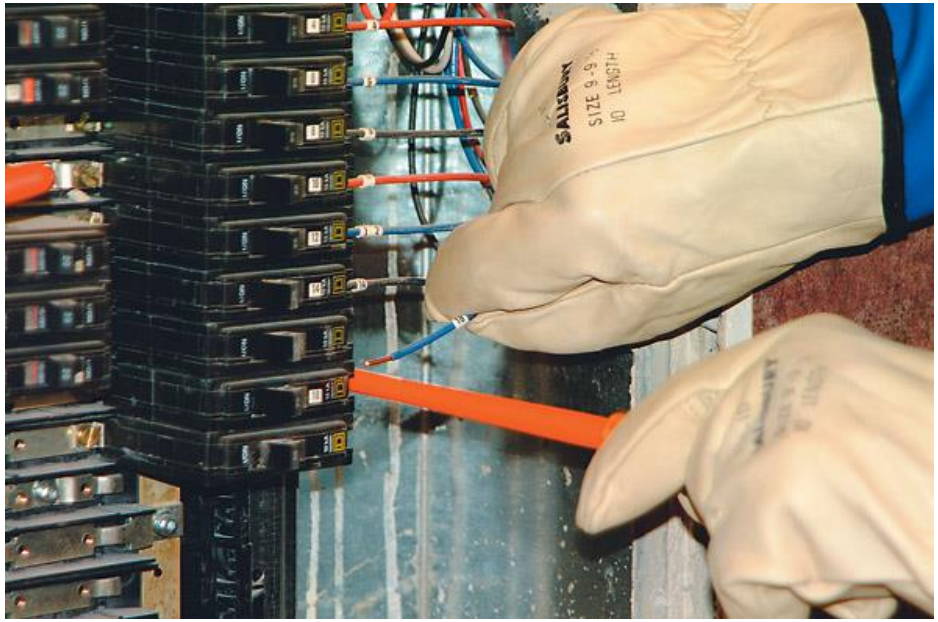
ENERGIZED (Electrically): Electricity Is Flowing Into And Powering A Piece Of Equipment In Order For It To Perform Its Function, i.e., The Equipment is "Live" or "Hot"

Only **QUALIFIED PERSONS** May Work On Energized Electric Circuit Parts Or Equipment

- Trained To Avoid The Electrical Hazards Of Working On Or Near Exposed Energized Parts



DE-ENERGIZED (Electrically) : All Parts Of The Equipment Have Been **Isolated** From Its Electrical Energy Source And **Verified** That It Will Not Operate By Using:

- Normal Operating Controls
- And A Test Instrument

Don't Work It Hot!

Make It Safe

With Careful Planning, Work Can Almost *Always* Be Done With Equipment *DE-ENERGIZED*

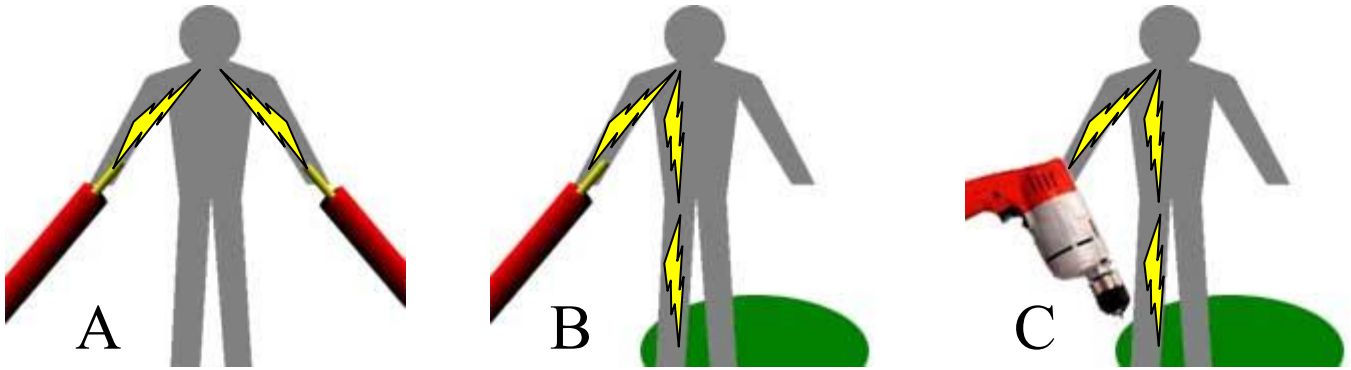
SHOCK HAZARD

Body Becomes Part Of The Electrical Circuit, i.e., In Contact With:

A. Both Wires Of An Energized Circuit

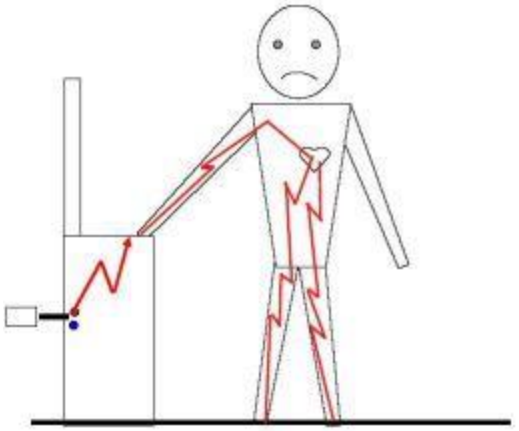
B. One Wire Of An Energized Circuit And The Ground

C. "Hot" Part (i.e., A Metallic Part Of A Tool In Contact With An Energized Wire) And The Ground
   - Due To Break In Insulation



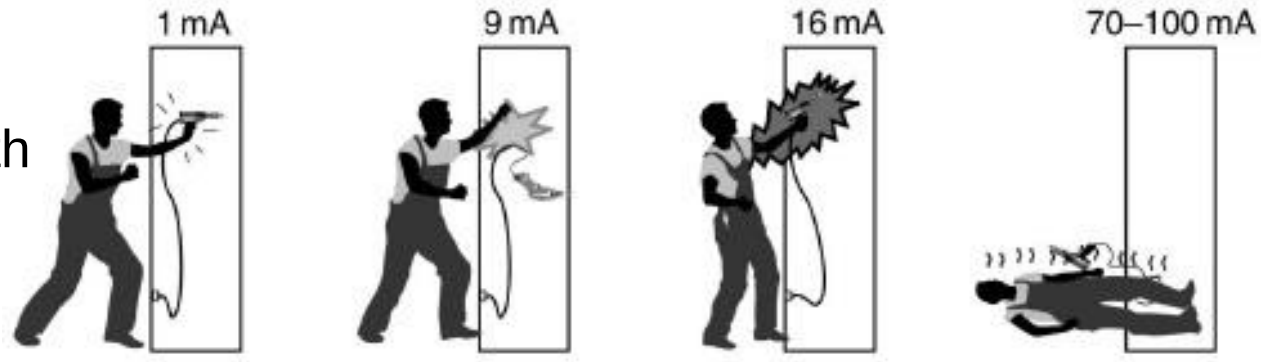
SHOCK HAZARD

Severity



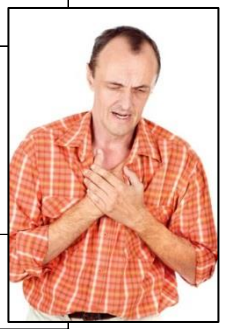
Depends On:

- Current Flow (Amps)
- Path Through Body
- Time
- Frequency
- Heart Cycle
- General Health



SHOCK HAZARD
Effects On Human Body

CURRENT	REACTION
> 5 mA	Generally Painful
> 15 mA	Strong Involuntary Reactions (50% of Population "Freezes" – Can't Let Go)
> 30 mA	Breathing Difficult
50 - 100 mA	Heart Fibrillation **DEATH Likely !**
100 - 200 mA	DEATH Probable
> 200 mA	Cardiac Arrest; Severe Burns; DEATH



As little as 27 Volts can be FATAL

SHOCK HAZARD

Effects On Human Body

Conductors - Offer Little Resistance To The Flow Of Electric Current

- Metals, Water

Insulators - Have High Resistance to the flow of electric current

- Porcelain, Pottery, Dry Wood

BODY PATH	RESISTANCE	CURRENT
Ear to Ear	100	1,100 mA
Head to Foot	500	220 mA
Dry Skin	350,000	0.3 mA
Wet Skin	1,000	110 mA

Low Resistance ⇨ High Current

High Resistance ⇨ Low Current

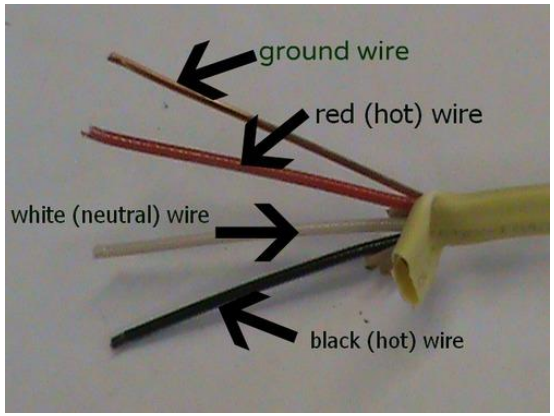
Dry Skin Has A Fairly High Resistance To Electric Current; But When Moist There Is A Drastic Drop In Resistance. Dry Your Hands Before Inserting/ Removing A Power Plug.

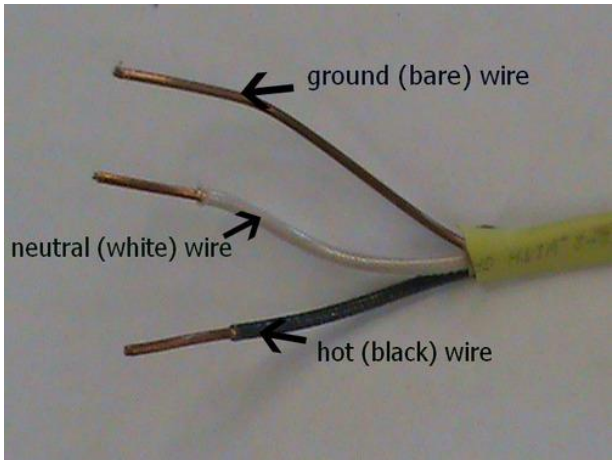
SHOCK HAZARD
Protective Measures

INSULATION

Material Located Between Points Of Different Potential To Prevent The Flow Of Electricity

- Most Common Causes Of Failure - Heat, Dirt, Chemicals, Moisture, Sunlight & Physical Damage





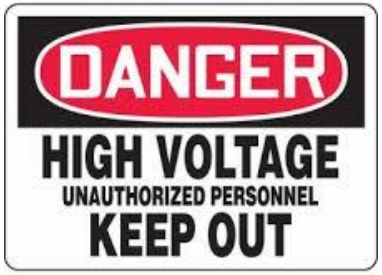
120 And 240 Volt Wire Color Codes
- Phase 1 - Black
- Phase 2 - Red
- Phase 3 - Blue
- Neutral - White Or Three White Stripes
- Ground - Green Or Green Striped

277 And 480 Volt Wire Color Codes
- Phase 1 - Brown
- Phase 2 - Orange
- Phase 3 - Yellow
- Neutral - Gray Or With 2 White Stripes
- Ground - Green With Yellow Stripe

SHOCK HAZARD
Protective Measures

GUARDING

- **> 50 V** Requires
  - Enclosed Room
  - Permanent Partitions
  - > 8’ Above Floor
  - Platform / Balcony / Gallery
- **> 600 V** Requires
  - Metal-Enclosed Equipment
  - Enclosed Vault Controlled by a Lock
  - Marked With Caution Signs



SHOCK HAZARD
Protective Measures

GROUNDING

***NOT a Guarantee** Against Shock*

Non-current-carrying Metallic System Components, Such As Equipment Cabinets, Enclosures, And Structural Steel, Need To Be Electrically Interconnected So Voltage Potential Cannot Exist Between Them Then A Low-Resistance Path To The Earth Is Provided

- **Service / System Ground**
  - White / Gray Wire Is Grounded At The Generator / Transformer & At The Service Entrance Of The Building
  - Protects Machines, Tools & Insulation Against Damage
- **Equipment Ground**
  - Additional Ground Path From Machine / Tool To The Ground
  - Protects Equipment Operator

SHOCK HAZARD
Protective Measures

CIRCUIT PROTECTION DEVICES

Protects Worker From Overcurrent & Short Circuits By Automatically Shutting Off The Electricity

- Overcurrent Caused By: Malfunction, Overheating, Too Much On A Circuit, Power Surge, Damaged Insulation

Circuit Breakers

Fuses

GFCIs

SHOCK HAZARD
Protective Measures

Plug Fuses

FUSES

- One-Time Use Over-Current Devices
  - **Fast-Blow** / One-Time: Protects From Sudden Current Surge
  - **Slow-Blow** / Time Delay: Ignores Momentary Current Surges
- Melts / Burns in Two When Set Current Value Is Exceeded
  - 15 / 20 / 30 amps - Household
  - 100 / 200 / Greater – Industrial

Industrial Fuses

Cartridge Fuses

SHOCK HAZARD
Protective Measures

Circuit Breakers

Over-Current Devices Designed To Trip Open The Circuit By Electromechanical Means When Set Current Value Is Exceeded

SHOCK HAZARD
Protective Measures


Receptacle GFCI

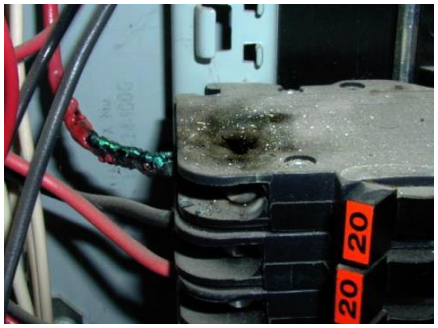
GROUND-FAULT CIRCUIT INTERRUPTER (GFCI)

Designed To Shutoff Electricity Within 1/40th of a Second

- Compares Current Going Into And Out Of Equipment
  - Interrupts Power If Differs More Than 6 mA
- Prevents Electrocution
- Used in High-Risk Areas
  - Wet Locations
  - Construction Sites

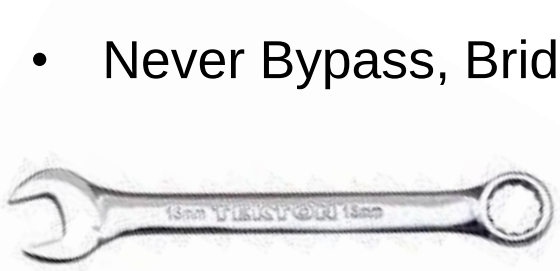
Portable GFCIs

SHOCK HAZARD
Protective Measures



Replace / Reset Circuit Protection

- Random Power Surge: Replace Fuse Or Reset Breaker
  - Use Exact Duplicate Fuse
    - Higher Rated Fuse Can Damage Equipment / Start A Fire
    - Lower Rated Fuse Could Explode
- Circuit Breaks Again Or If There Is Smoke, Heat Or Unusual Odor
  - Immediately De-Energize
  - Do Not Keep Resetting Breaker - Find The Problem
- Never Bypass, Bridge Or Disable






SHOCK HAZARD
Protective Measures

Underground Utilities

South Carolina State Law: Any activity that results in the movement or removal of earth, rock or other materials in or on the ground requires the excavator to contact the Utility Company or One Call Center with adequate information regarding the dig. Each excavator is required to wait 72-hours or 3 business days before starting the digging work.

A Palmetto Utility Protection System (PUPS) representative will record the location of the digging site and notify member utility companies of the intent to dig. Utility companies will then send out a professional locator to your site to mark the approximate location of utility lines. Once your lines have been marked, you may begin to carefully excavate around the marked lines.

Identify Utility Locations Before Digging

SHOCK HAZARD
Protective Measures

Overhead Power Lines

Prevent Contact

- Unqualified Employees And Mechanical Equipment Must Stay 10’ Or More Away
  - Add 4” For Each 10,000V Over 50,000V
- Employees Standing On The Ground May Not Contact The Equipment Unless Clear
- Use CAUTION When Carrying Metal Ladders, Long Pieces Of Pipe, Steel Or Lumber, Or Using Boom Trucks

Equipment Service/ Maintenance Required

- Setup
- Adjustments
- Repairs
- Cleaning
- Lubrication
- Clearing a Jam

Expect Startup or Release of Stored Energy?

YES

No

Must Bypass Safety Device?

YES

No

Can place any body part where can be caught in machinery?

YES

No

LOTO Required

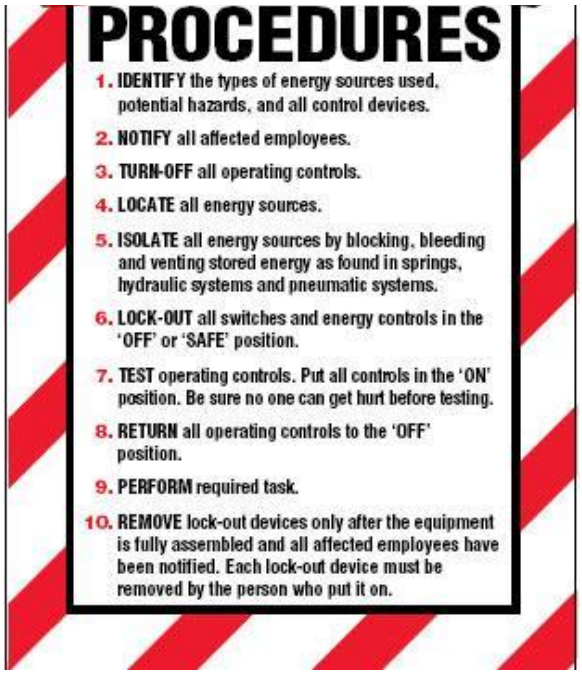
Refer To

LOTO Not Required

(Perform Work)

SHOCK HAZARD
Protective Measures

LOCKOUT TAGOUT



LIVE (HOT) WORK!

Work On Live Equipment Is Only Allowed If It Can Be Shown That De-Energizing:

- Introduces Additional or Increased Hazards
  - Interruption of Life Support Equipment
  - Deactivation of Emergency Alarm Systems
  - Shutdown of Hazardous Location Ventilation Equipment
  - Removal of Illumination for a Critical Work Area
- Is Infeasible Due to Equipment Design or Operational Limitations
  - Diagnostics & Testing of Electric Circuits That Can Only Be Performed With the Circuit Energized (Trouble-Shooting)
  - Work on Single Circuit / Piece of Equipment Would Shutdown Entire Industrial Process

Financial or Customer Comfort Considerations are **NOT** Adequate Reasons to Work On or Near Energized Circuits

LIVE (HOT) WORK! PERMIT

… And The Supervisor And Employees Complete A **LIVE WORK PERMIT** Designating:

- Job To Be Done
- Employees Involved
- Procedures & Tools To Protect The Workers
- Rescue Recovery Operations
- Limited Time Frame

NEVER Work On A Live Circuit Alone

- Have Standby Worker Trained In Emergency Response

(See Next Page For DGS "Live Work" Permit)

Electrical Safety

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ENERGIZED ELECTRICAL WORK PERMIT

The Completed Permit Is To Be Kept At The Job Site Until The Job Is Done

1. LIVE WORK TASKING

Work Location: _____ Work Order Number: _____
(Building Name, Room Number)

Start Date: _____ Time: _____

Equipment To Be Shut Down: _____

___ Until Work Is Completed ___ Temporarily While Barriers Are Placed

Description Of Planned Work Activities Including Involved Components: _____

_____

_____ Voltage: _____V

2. PERSONNEL ASSIGNED TO PERFORM THE LIVE WORK

Qualified Electrician(s): _____

Qualified Electrician Certified In CPR-1ST Aid-AED: _____

Assistant/Attendant(s) (Un-Qualified): _____

3. JUSTIFICATION FOR THE LIVE WORK

The Work Cannot Be Delayed To Allow The Equipment To Be Shutdown and De-Energized For Maintenance. Work On Energized Electrical Equipment Is Justified Because The Equipment Shutdown And De-Energizing:

Creates an:

__ Increased Hazard (specify): _____

__ Additional Hazard (specify): _____

Is infeasible due to:

__ Equipment Design (specify): _____

__ Operational Limitations (specify): _____

4. METHODS TO RESTRICT UNAUTHORIZED PERSONS FROM THE WORK AREA

__ Signs / Tags __ Barricades __ Attendants

5. HAZARD ANALYSIS (To be completed by the Qualified Electrician(s) and Supervisor)

Work will be conducted within the following Approach Boundaries:

FLASH PROTECTION BOUNDARY – 4 ft 0 in for systems 600 volts or less or Calculated: ___ ft ___ in

Select VOLTAGE	LIMITED (Movable Conductor)	LIMITED (Fixed Circuit Part)	RESTRICTED	PROHIBITED
50 – 300 v	10 ft	3 ft 6 in	Avoid Contact	Avoid Contact
301-750 v	10 ft	3 ft 6 in	1 ft	1 in

Hazard Risk Category	1	2	3	4
Required Fire Resistant Clothing ATPV Rating (in cal/cm²)	4	8	25	40

__ Voltage-rated gloves
__ Safety glasses
__ Hearing Protection
__ Leather gloves
__ Rubber sleeves
__ Hard Hat-Class G / E
__ Hard Hat FR liner*

__ Short-sleeve shirt (natural fiber)
__ Long-sleeve shirt (natural fiber)
__ Long pants (natural fiber)
__ Long-sleeve FR shirt*
__ Long FR pants*
__ FR coveralls*
__ Under layers that do not melt

__ Multi-layer FR flash suit jacket*
__ Multi-layer FR flash suit pants*
__ Arc-rated face shield*
__ Flash suit hood*
__ FR jacket/rainwear*

*- Arc Thermal Protective Value (ATPV)

__ Communications
__ Conductive jewelry / items removed
__ Fire Extinguisher

__ Dielectric/rubber insulating mat
__ Voltage test equipment of compatible rating and checked

__ Adequate/additional lighting
__ Voltage-rated insulated tools
__ Non-conductive portable Ladder

6. OTHER SAFE WORK PRACTICES (description; attach sheet, as required): _____

_____

_____

7. ENERGIZED ELECTRICAL WORK REVIEW

Equipment Will Be De-Energized And Isolated To The Extent Feasible. I Agree The Remaining Energized Electrical Work As Described Above Can Be Done Safely.

QUALIFIED ELECTRICIANS: _____ Date: _____
(Assigned To Work Task) (Name)

_____ Date: _____

I Verify That Energized Electrical Work Preparations Have Been Completed And The Assigned Employees Have Been Briefed With Detailed Procedures And Are Properly Equipped.

SUPERVISOR: _____ Date: _____
(Name)

Send Copy to BCB Safety; Copy kept by Supervisor; Copy kept at work site until job completed

8. WORK COMPLETION End Date: _____ Time: _____

Send completed form to: JP Gouffray, FM Energy-Environmental (To be kept on file for 1 year) as of 3 March 2011

Electrical Safety

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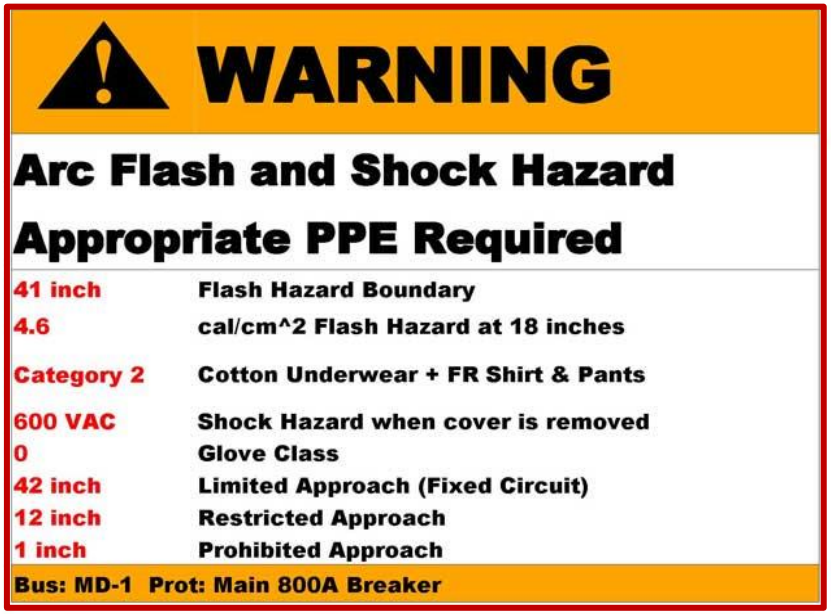
Electrical Equipment (Switchboards, Panelboards, Industrial Control Panels, Meter Socket Enclosures, And Motor Control Centers) That Is **Likely To Require** Examination, Adjustment, Servicing Or **Maintenance *While Energized*, *SHALL* Be Field Marked With A Label** Containing:

- **At Least One Of The Following**:
  - Available Incident Energy And The Corresponding Working Distance
  - Minimum Arc Rating Of Clothing
  - Required Level Of PPE
  - Highest Hazard/Risk Category (HRC) For The Equipment
- **Nominal System Voltage**
- **Arc Flash Boundary**



Per NFPA 70E (2012)

ARC FLASH Hazard

To Minimize Exposure To Arc Flash
When Turning Off & Restoring Power –

Use One-Handed Technique

- **Wear Appropriate PPE**
- **Stand To The Side & Sideways**
- **Use One Hand**

SHOCK HAZARD
Protective Measures

Test Equipment

- Only Qualified Person Is Allowed to Test
- Test The Multi-Meter On A "Live" Source Before Checking Equipment
- Dissipate Capacitors Prior To Testing
- Set To Appropriate Scale Rating (Set High Then Come Down)

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LIVE (HOT) WORK!

Electrical Parts Are Considered ***Energized*** Until All Lockout-Tagout (LOTO) Steps Are Completed

- Placing an Electrical Conductor or Circuit Part in a Safe Work Condition (Off & ***De-Energized***) Is in Itself a Potentially Hazardous Task
- Voltage Testing While Completing LOTO Is Considered As Working on Live (Energized) Parts

Personal Protective Equipment
Flame Resistant (FR) Clothing

7,000 Electrical Burn Injuries
In The Work Place Each Year

- The Most Severe Burns Are Caused By Ignited Clothing

  Not From The Initial
  Arc Flash Fire And Explosion

- **Do Not Wear Synthetic Fabric**

  It ***Melts*** (into your skin)

  - Acetate, Nylon, Polyester, Rayon or Blends

Personal Protective Equipment
Flame Resistant (FR) Clothing

Type Of FR Clothing Required For Work On Or Near Systems Rated At:

- **240 Volts & Below** (Low-Energy work)
  - Natural-fiber / Non-Synthetic Clothing Is Adequate for Many Tasks
  - Some Higher Risk Tasks Require Flame Resistant (FR) Clothing
- **241 - 559 Volts**
  - Requires at Least One Layer of FR Clothing Worn Over Natural-fiber Clothing

Electrical Safety

Be Smart. Be Safe.

For *Energized* Electrical Equipment (Not Made Safe) < 240 Volts

Facilities Management Trades Specialists Are To Wear:

Long Sleeved Cotton Uniform Shirt and Trousers

Safety Glasses

Leather Work Shoes with Rubber Soles

Recommended:

Hard Hat rated for at least 2,200 v

Leather Gloves

Arc Flash Rated Face Shield (Over Safety Glasses)

Non-Synthetic Under Layers

Electrical Safety

OSHA Be Smart. Be Safe.

For *Energized* Electrical Equipment (Not Made Safe) 241-599 Volts

Facilities Management Trades Specialists Are To Wear:

Flame Resistant Coverall

(Arc Rating - 8)

AND…

Hard Hat rated for at least 2,200 v

Arc Flash Rated Face Shield Over Safety Glasses

Long Sleeved Uniform Shirt and Trousers & Layers Underneath Of Natural Materials (Cotton / NOT Synthetic)

Leather Gloves

Leather Work Shoes with Rubber Soles

Personal Protective Equipment
Arc Rated vs. Flame Resistant Clothing

Arc Rating Of PPE Is To Be Matched To The Arc Flash Hazard

- FR Rating Means The Material Will Not Ignite Or Continue To Burn When Heat Source Is Removed
- Knowing The Arc Rating Of The Equipment Allows The Employee To Make A Proper Selection For FR Protection. The Higher The Number The More Protection.
  - Not All FR Clothing Is Arc Rated But All Arc Rated Clothing Is Flame Resistant
  - Arc Rated Clothing Provides Insulation To Prevent Fatal 3rd Degree Burns
    - Can Still Receive Survivable 2nd / 1st Degree Burns

Examples: If Arc Flash Hazard Is -
- 6 Calories Then FR PPE Rating of 8 is OK
- 10 Calories Then FR PPE Rated of 8 Is Not Sufficient; Requires An Additional Layer Or Higher Arc Rated Clothing

Personal Protective Equipment
Arc Rated/Flame Resistant Clothing

- As The Heat From An Arc Flash Can Cause Garments Worn Under Arc Rated Clothing To Ignite, Those Under Layers Should:
  - Not Be Made Of Synthetic Materials
  - Be Made Of Natural Materials, i.e., Cotton
- Clothing Made From The Following (Synthetic) Fabrics, Alone Or In Blends, Is Prohibited Unless Treated (To Be Flame Resistant): Acetate, Nylon, Polyester, Rayon 29 CFR 1910.269(l)(6)

Synthetic Garments Will Melt Into Skin

Natural, i.e., Cotton

Personal Protective Equipment
Hard Hat Ratings

- **Type 1** – Reduce Impact Force From Blow To Top Of Head
- **Type 2** - Reduce Impact Force From Blow To Top Or Sides Of Head
- **Class G (General)** – Reduce Danger Of Contact With Low Voltage (Tested At 2,200 Volts Phase To Ground)
- **Class E (Electrical)** - Reduce Danger Of Contact With Higher Voltages (Tested At 20,000 Volts Phase To Ground)
- **Class C (Conductive)** – Not Intended To Protect Against Electrical Hazards

ANSI Head Protection Standard Z89.1

Electrical Safety

OSHA Be Smart. Be Safe.

For *Energized* Electrical Equipment (Not Made Safe) 600 Volts & Above
(High-energy tasks)

(FM Trades Specialists Normally DO NOT Work At These Voltages; Assist Power Company)

Flame Resistant Flash Suite
(Arc Rating - 40) *Worn Over…*

Arc Flash Rated
Face Shield Over
Safety Glasses

Long Sleeved Uniform Shirt
and Trousers & Layers
Underneath Of
Natural Materials
(Cotton / NOT Synthetic)

Leather Gloves

Leather Work Shoes
with Rubber Soles

…and Use Protective Equipment/Insulated Tools

Insulated or Non-Sparking Tools

Grounding Cables

Fuse Pullers

Static Discharge Stick

Dielectric Mats

Rubber / Composition Gloves / Sleeves

- Personally Assigned
- Inspect & Air Test At Start Of Each Day
- To Be Regularly Lab Tested Every 6 Months

When To Wear PPE?

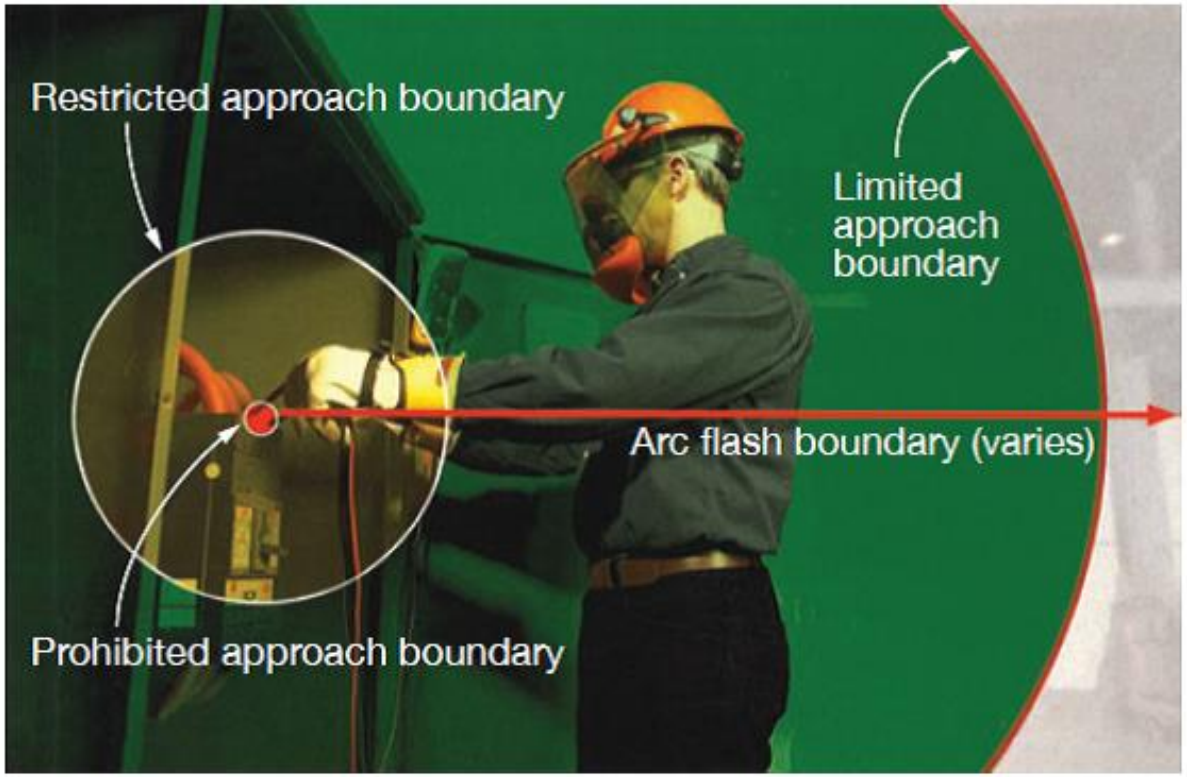
The ARC Flash Protection Boundary

Is The **Minimum Safe Distance** From *Energized* Electrical Equipment Without Need To Wear PPE

- Distance Increases As:
  - Fault Current Level Increases
  - The Longer The Fault Is Allowed To Exist
- **Minimum Of 4 Feet** For Systems **600 Volts Or Less**
  - To Prevent 3rd Degree Burn (= Life-threatening) (2nd Degree Burn Or Less Is Curable)
- **PPE Must Be Worn Within Boundary** *(50 Volts Or More)*
  - NFPA 70E 3-1 & OSHA 1910.335(a)(1)(i)

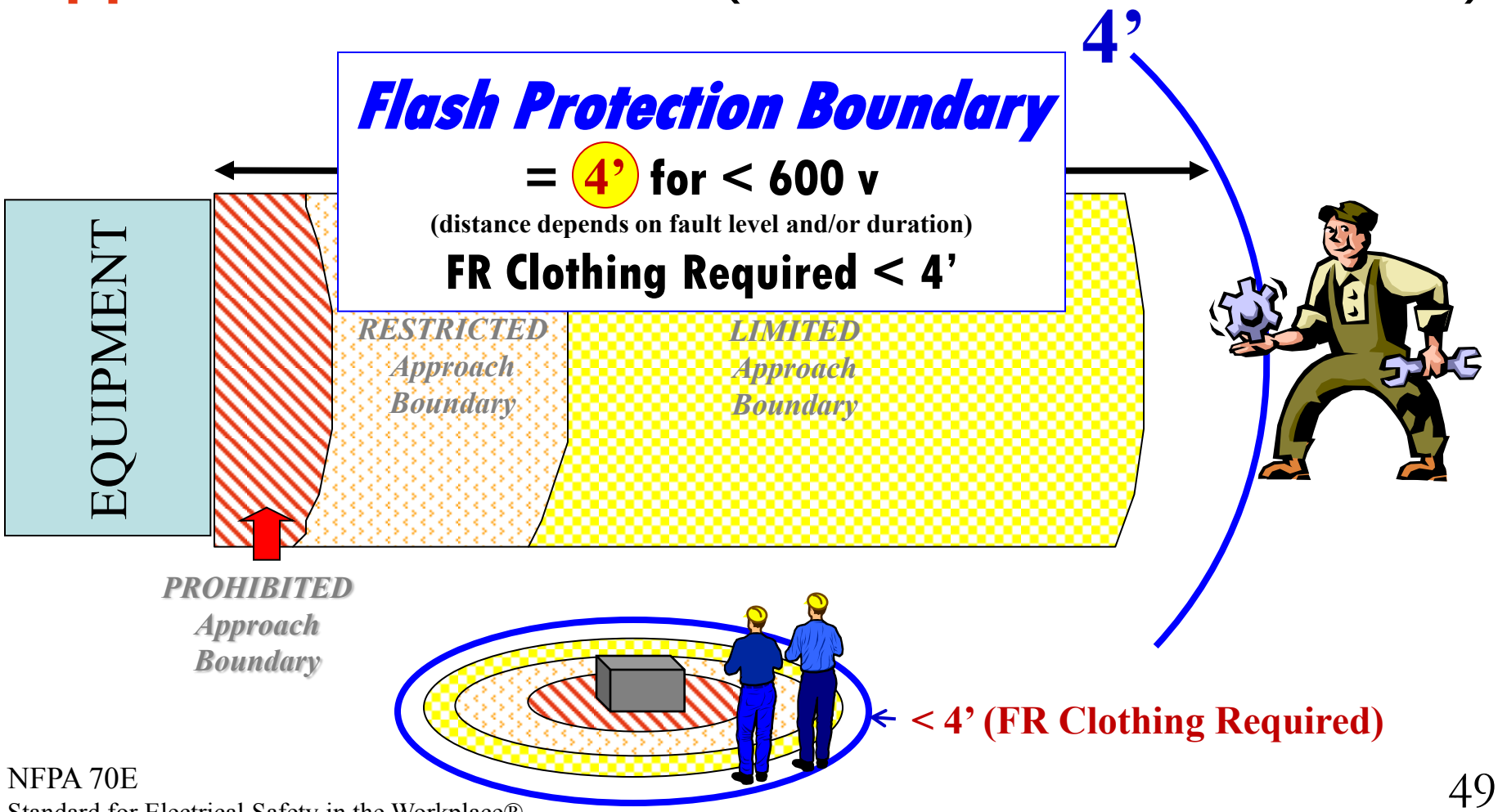
- Temperatures Up To $35,000^0$ F
  - Fatal Burns Over 10' Away
- Pressure & Sound Waves
  - In Excess Of 200 Lbs/Ft^2
- Molten Metal
- Copper Vapor
- Intense Light
- Shrapnel

Approach Boundaries (for *"Live"* Electrical Work)

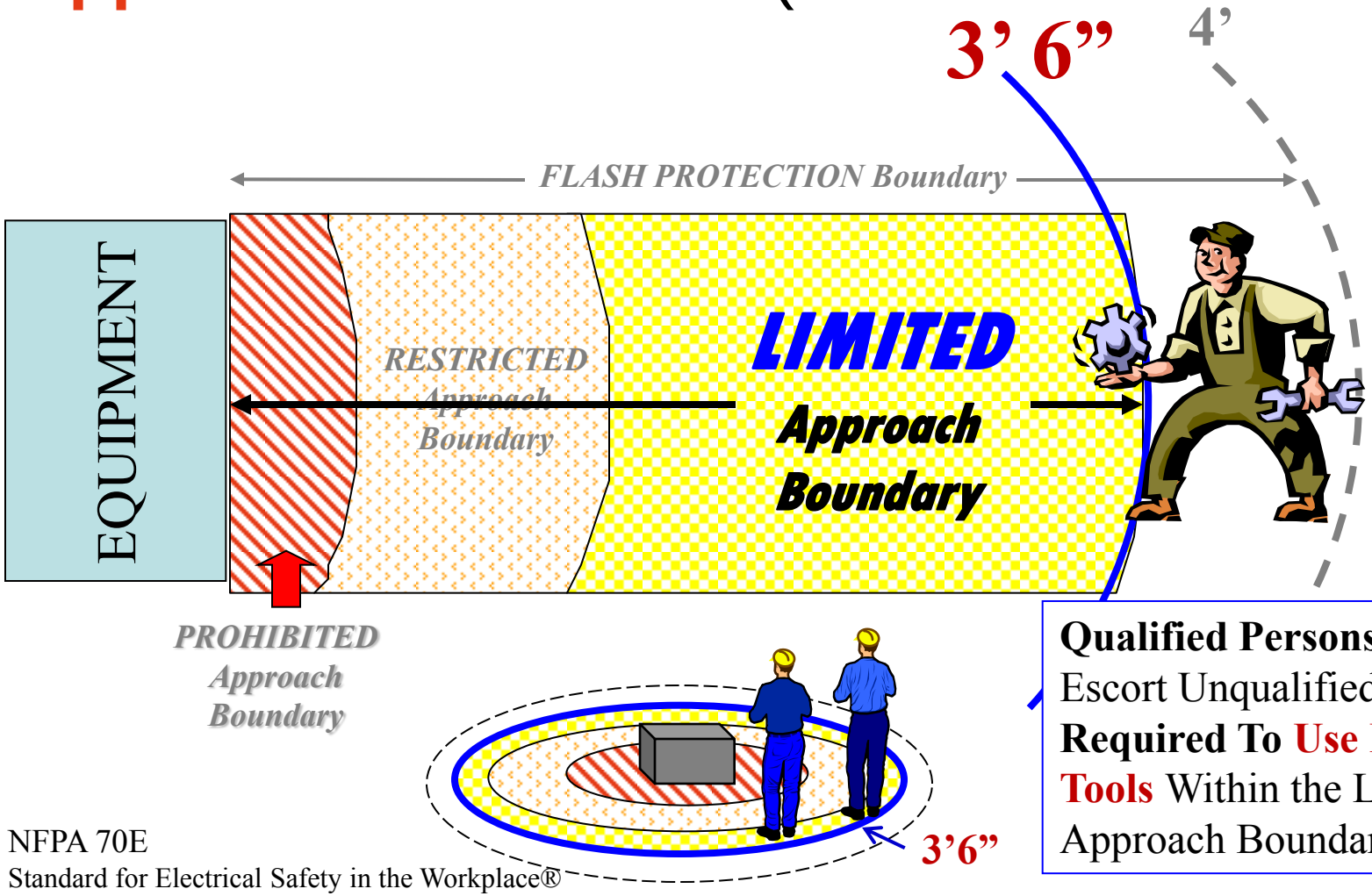


NFPA approach boundaries (2012 edition)

Approach Boundaries (for *"Live"* Electrical Work)



Approach Boundaries (for *"Live"* Electrical Work)



Qualified Persons (Who Can Escort Unqualified Persons) **Required To Use Insulated Tools** Within the Limited Approach Boundary

Electrical Safety

OSHA Be Smart. Be Safe.

QUALIFIED PERSONS must have electrical-related training sufficient to effectively avoid the electrical hazards associated with work on, or near, exposed energized parts. These qualified persons must be capable of working safely on energized circuits. This capability includes familiarity with the proper use of:

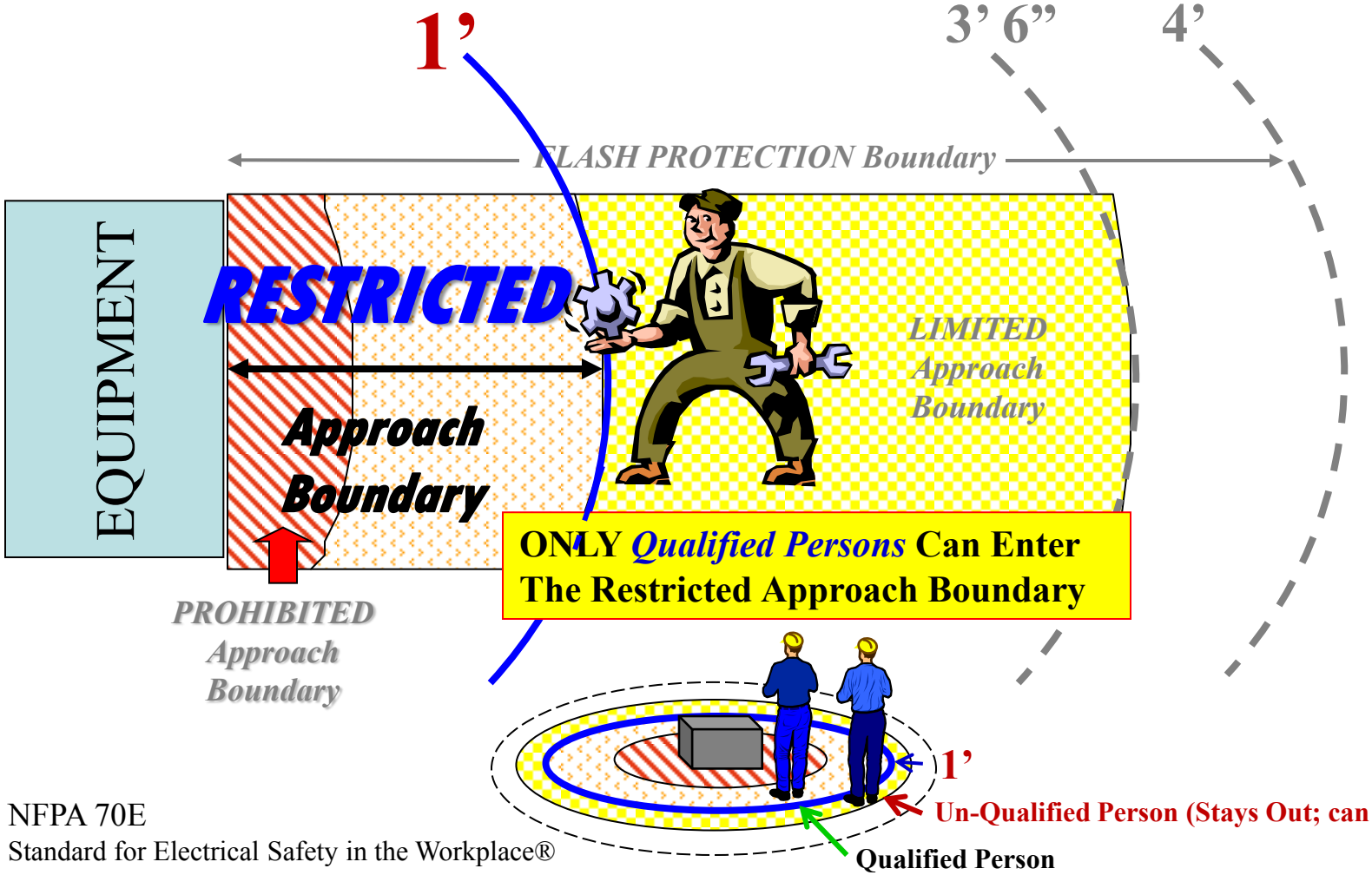
- Special Precautionary Techniques
- Personal Protective Equipment
- Insulating Or Shielding Materials, and
- Insulated Tools.

The operator or foreman would have to meet the qualifications referenced above (and fully detailed in Subpart S) before examining or troubleshooting a circuit that is energized above 50 volts.

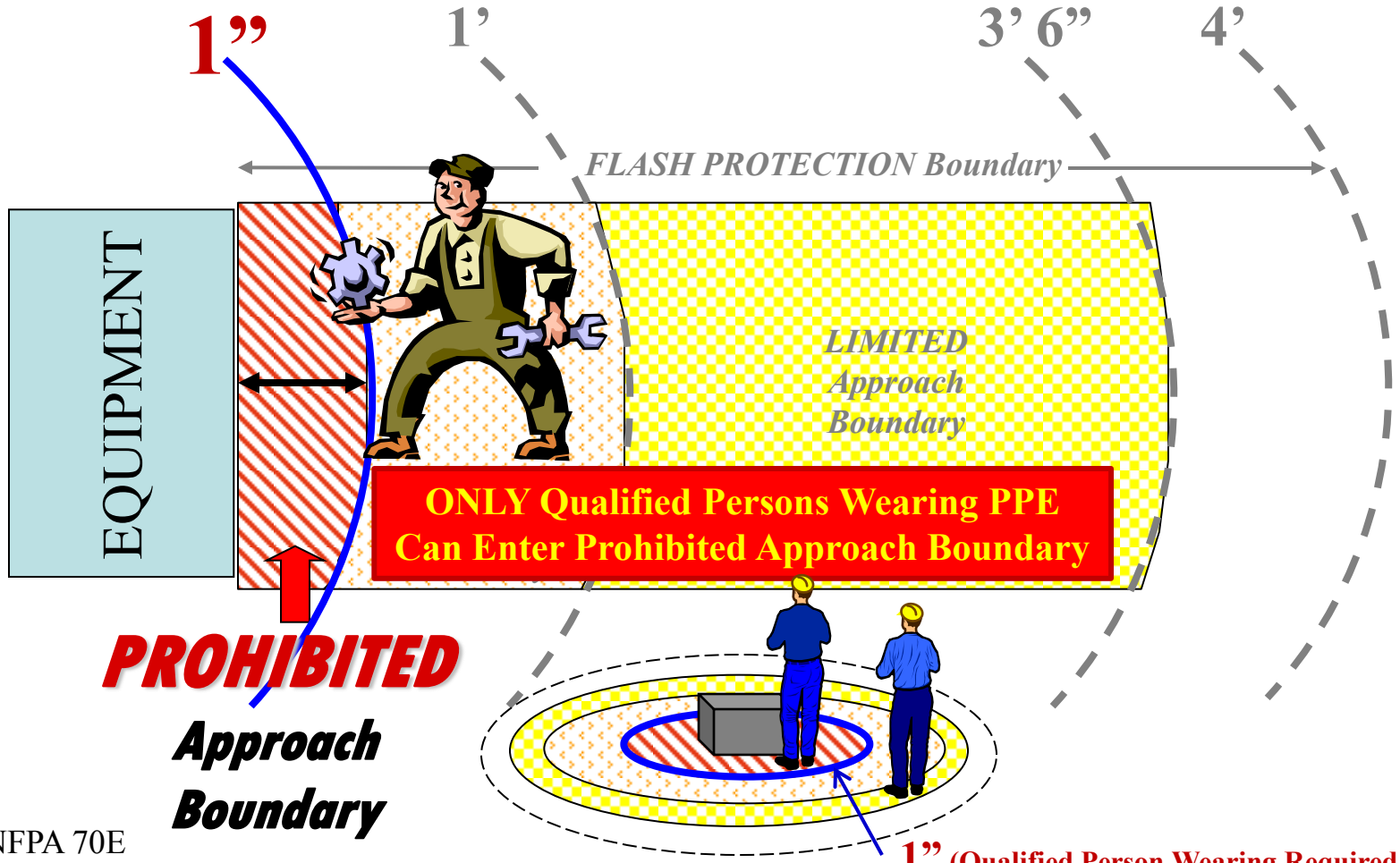
Employees Undergoing On-The-Job Training To Become A "Qualified Employee" Must Be ***Under The Direct Supervision Of A Qualified Person At All Times*** Until They Have Demonstrated Proficiency In The Work Practices Involved With Their Work.

OSHA Letters of Interpretation, 11/19/01 & 5/17/02

Approach Boundaries (for *"Live"* Electrical Work)

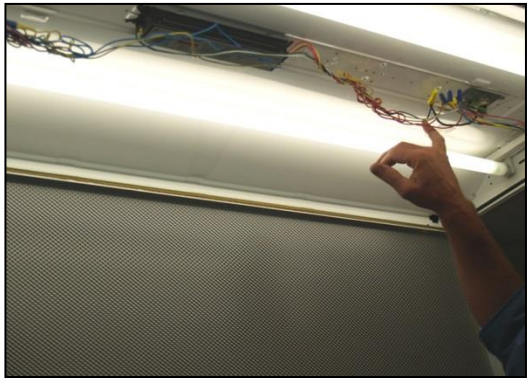


Approach Boundaries (for *"Live"* Electrical Work)



LIVE (HOT) WORK!

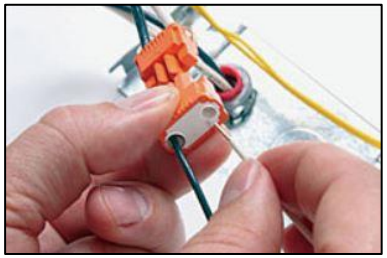
DGS Special Procedure To **Change A Light Ballast**

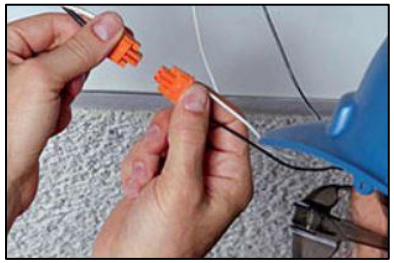


No.	Energy Source/ Location	Procedure (**New Ballast** to Include Installation of **Quick Connect**/Disconnect Power Plug)
1	Fixture	Open or remove lens or light fixture cover
2	Fixture	Remove lamp(s) and ballast cover.
3	Electricity	Inspect wiring for proper working length and that the wires are not damaged or frayed.
4	Electricity	If improper length or damaged wire is present or any other unsafe conditions are found: Proper Lock Out – Tag Out procedures must be conducted. See “Removing Light Fixture From Service” procedure.
5	Electricity	If conditions are safe, proceed with voltage meter to identify the hot wire.

LIVE (HOT) WORK!

DGS Special Procedure To **Change A Light Ballast** (cont.)

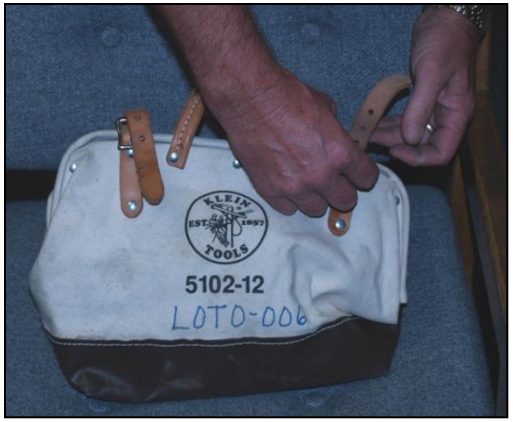




No.	Energy Source/ Location	Procedure (**New Ballast** to Include Installation of **Quick Connect**/Disconnect Power Plug)
6	Electricity	Disconnect hot wire first (colored wire) and isolate.
7	Electricity	Disconnect neutral (white) wire second and isolate.
8	Fixture	Remove ballast and/or repair fixture.
9	Fixture	Install new ballast.
10	Fixture	Correctly wire-in quick connect/disconnect power plug on load side neutral first and hotwire second. Safely tuck wires up.
11	Fixture	Install ballast cover, lamps and lens or light fixture cover.

LIVE (HOT) WORK!

DGS Special Procedure To Change A Light Ballast (cont.)



No.	Energy Source/ Location	Procedure – **REMOVING Light Fixture From Service**
1	Electricity	Turn OFF power at light switch and install Lockout-Tagout device (as shown).
2	Electricity	If the number of power switches are unknown, turn off power of the designated light fixture(s) at the labeled Breaker Panel, and install Lockout-Tagout device(s).
3	Fixture	Ensure that the light fixtures are disconnected from the energy sources by: 1) Checking there are no personnel exposed 2) Verify the isolation of the light fixture(s) by testing the light switch or other normal operating control(s) or by testing to make certain the light fixture(s) will not operate.
4	Fixture	The fixture is now locked out. Install 2-wire or 3-wire Quick Connect/Disconnect to new fixture.

LIVE (HOT) WORK!

DGS Special Procedure To Change A Light Ballast (cont.)

No.	Energy Source/ Location	Procedure – **RESTORING Light Fixture To Service:** When the servicing or maintenance is completed and the light fixture is ready to return to normal operating condition, the following steps shall be taken.
1	Fixture	Check the light fixture and the immediate area around the light fixture to ensure that nonessential items have been removed and that the light fixture components are operationally intact.
2	Fixture	Check the work area to ensure all maintenance personnel have been safely positioned or removed from the area.
3	Fixture	Remove the Lockout-Tagout device(s), re-energize the light fixture(s) and return the lighting to regular service.
4	Fixture	Notify affected employees that the servicing or maintenance is completed and the lighting is ready for use.

OSHA Be Smart. Be Safe.

Review:

- Dangers of Arc Flash
- Approach Boundaries for Qualified & Unqualified Persons
- PPE (Fire Resistant) Clothing & Tool Requirements
- Posting of Arc Flash Labels
- LOTO Procedures
- Energized Electrical "Live" Work Permit
- Procedure to Change Light Ballast

Questions?

Call

Robert Huff, FM Bldg Maintenance, 734-3407
or BCB Safety, 737-2315

Course Exam

Remember

To Receive Credit For This Course Turn In Your Completed Test To The Safety Office

Passing Grade is **70%** Or Better